Species at Risk Act
Recovery Strategy Series

Recovery Strategy for the American Ginseng (*Panax quinquefolius*) in Canada

American Ginseng

2018

Government of Canada
Gouvernement du Canada

Canada

Recommended citation:

Environment and Climate Change Canada. 2018. Recovery Strategy for the American Ginseng (*Panax quinquefolius*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment and Climate Change Canada, Ottawa. vii + 32 pp.

For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) Status Reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk (SAR) Public Registry[1].

Cover illustration: Andrée Nault, Biodôme de Montréal ©

Également disponible en français sous le titre
« Programme de rétablissement du ginseng à cinq folioles (*Panax quinquefolius*) au Canada »

© Her Majesty the Queen in Right of Canada, represented by the Minister of Environment and Climate Change, 2018. All rights reserved.
ISBN 978-0-660-25762-4
Catalogue no. En3-4/290-2018E-PDF

Content (excluding the illustrations) may be used without permission, with appropriate credit to the source.

[1] http://sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c. 29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the SAR Public Registry.

The Minister of Environment and Climate Change and Minister responsible for the Parks Canada Agency is the competent minister under SARA for the American Ginseng and has prepared this recovery strategy, as per section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Governments of Ontario (Ministry of Natural Resources and Forestry) and Quebec (Ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques) as per section 39(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy and will not be achieved by Environment and Climate Change Canada and the Parks Canada Agency, or any other jurisdiction, alone. All Canadians are invited to join in supporting and implementing this strategy for the benefit of American Ginseng and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and the Parks Canada Agency and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to appropriations, priorities, and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species including migratory birds SARA requires that critical habitat identified in a federally protected area[3] be described

---

[2] www.sararegistry.gc.ca/approach/strategy/default_e.cfm

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the *Migratory Birds Convention Act, 1994* or a national wildlife area under the *Canada Wildlife Act* see ss. 58(2) of SARA.

in the *Canada Gazette* within 90 days after the recovery strategy or action plan that identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under ss. 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act, 1994* applies as per SARA ss. 58(5.1) and ss. 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to prohibit destruction of critical habitat. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgments

This recovery strategy was developed by Vincent Carignan and Alain Branchaud (Environment and Climate Change Canada, Canadian Wildlife Service [EC-CWS] – Quebec Region) based on a draft by Andrée Nault (Montreal Biodome) and in collaboration with:

EC-CWS – Ontario Region: Angela McConnell, Lee Voisin, Marie-Claude Archambault, Krista Holmes and formely Madeline Austen.

EC-CWS – Quebec Region: Karine Picard, Geneviève Langlois, Matthew Wild, Emmanuelle Fay and Manon Dubé.

EC-CWS – National Capital Region: Paul Johanson and Manon Dubé.

Ontario Ministry of Natural Resources and Forestry (MNRF): Jay Fitzsimmons, Eric Snyder, Aileen Wheeldon, Shaun Thompson, Roxanne St. Martin, Tom Croswell, Dr. Brian Naylor, Jim Saunders, Daryl Coulson, Corina Brdar, Ron Gould, Amanda Fracz, Vivian Brownell and Jim Mackenzie.

Ministère du Développement durable, de l'Environnement et de la Lutte contre les Changements Climatiques (MDDELCC): Patricia Désilets, Évelyne Barrette, Guy Jolicoeur, Line Couillard and Vincent Piché.

Parks Canada Agency (PCA): Vicki Leck (now at CWS-ON), Beth McEachern, Josh Van Wieren, Hillary Knack, Leonardo Cabrera and Gary Allen.

The following people also commented on the document or provided information to improve its content: Caroline Tanguay (Nature Conservancy Canada), Department of National Defence staff members; Jean-François Dubois, Jacinthe Bélec and Lonny Coote (EC - Wildlife Enforcement Directorate); Adrianne Sinclair and Andrea White (EC-CWS– CITES), as well as Marie-José Ribeyron (consultant), Don Cuddy and Marjorie Mercure[4].

[4] Formerly with EC-CWS – Quebec Region

Executive Summary

American Ginseng (*Panax quinquefolius*) is a long-lived perennial plant associated with mature forests. The species was designated as Endangered by the Committee for the Status of Endangered Wildlife in Canada (COSEWIC) in 2000 and has been listed with the same status under Schedule 1 of the *Species at Risk Act* (SARA) since 2003.

Less than 1% of the global population of American Ginseng occurs in Canada. Although there is a consensus that the species is severely declining, lack of information relating to the number of extant populations as well as the absence of abundance data for many of them precludes population trend analyses.

The main threats to the American Ginseng are illegal root harvest, deforestation (industrial, urban and agricultural expansion); browsing, predation and diseases (mortality); introduced and invasive species; forest harvesting; commercial cultivation; as well as climate change. Small population size, a long time to reach maturity and climatic constraints are considered limiting factors.

There are unknowns regarding the feasibility of recovery of the American Ginseng. Nevertheless, in keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA as would be done when recovery is determined to be feasible.

The population and distribution objectives for the American Ginseng in Canada are:

- Over the short term (2018-2028): Maintain or increase the abundance of American Ginseng plants and the area of occupied suitable habitats at each extant occurrence;
- Over the long term (2018-2038): Ensure the viability of all extant occurrences and, where technically and biologically feasible, restore historical or extirpated occurrences.

Broad recovery strategies and approaches to achieve these objectives are presented in the Strategic Direction for Recovery section.

Critical habitat for the American Ginseng is partially identified in this recovery strategy. It corresponds to the areas of suitable habitat within a 150 m critical function zone around each American Ginseng record. A total of 455 critical habitat units containing 8,268 ha within the critical habitat zone are identified in Canada: including 334 in Ontario (3,635 ha) and 121 in Quebec (4633 ha). Due to the sensitivities of the species (e.g., to illegal harvest), the Minister of the Environment and Climate Change, on the advice of COSEWIC, has restricted the release of information that relates to the location of American Ginseng or its habitat (SARA s. 124). A schedule of studies outlines key activities to complete the identification of critical habitat.

One or more action plans will be posted on the Species at Risk Public Registry before the end of 2023.

Recovery Feasibility Summary

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, there are unknowns regarding the feasibility of recovery of the American Ginseng. In keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA as would be done when recovery is determined to be technically and biologically feasible. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

1. Individuals of the wildlife species that are capable of reproduction are available now or in the foreseeable future to sustain the population or improve its abundance.

Yes. Mature individuals remain in many parts of the species' range, including within viable populations. However, the species is rare or uncommon, even in the United States where it is more widely distributed. Accordingly, a rescue effect from populations in the United States is considered to have a low probability. *Ex situ*[5] individuals grown from seeds could be used to increase depleted populations or for reintroduction purposes.

2. Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.

Yes. Mature forests with suitable attributes exist throughout the range and populations of American Ginseng have been newly discovered within those habitats in recent surveys. Forest management as well as restoration will likely be necessary for many American Ginseng populations that are in a depleted state.

3. The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.

Unknown. Most of the threats (e.g., deforestation, plant and seed mortality) can be mitigated through stewardship efforts and adaptive forest management. Mitigating illegal harvest will likely remain the main challenge and will require close collaboration between the various stakeholders to efficiently enforce existing laws and regulations.

4. Recovery techniques exist to achieve the population and distribution objectives or can be expected to be developed within a reasonable timeframe.

Unknown. A high level of effort will be required to fully recover this species because it is unlikely that the main threats will ever be completely eliminated. It is anticipated that active management and law enforcement measures will always be required to counteract illegal harvest of wild roots and to counteract the constant pressure for development and forest harvesting in natural habitats. However, recovery efforts could

[5] Off-site

be supported with relatively simple and low cost techniques such as supplemental seeding and transplantation (preferably from individuals from the same site).

Table of Contents

Preface i
Acknowledgments iii
Executive Summary iv
Recovery Feasibility Summary v
1. COSEWIC Species Assessment Information 1
2. Species Status Information 1
3. Species Information 2
3.1 Species Description 2
3.2 Species Population and Distribution 2
3.3 Needs of the American Ginseng 4
4. Threats 6
4.1 Threat Assessment 6
4.2 Description of Threats 7
5. Population And Distribution Objectives 10
6. Broad Strategies and General Approaches to Meet Objectives 11
6.1 Actions Already Completed or Currently Underway 11
6.2 Strategic Direction for Recovery 13
7. Critical Habitat 15
7.1 Identification of the Species' Critical Habitat 15
7.2 Schedule of Studies to Identify Critical Habitat 19
7.3 Activities Likely to Result in the Destruction of Critical Habitat 19
8. Measuring Progress 22
9. Statement On Action Plans 22
10. References 23
Appendix A: Critical Habitat for the American Ginseng in Canada 30
Appendix B: Effects on the Environment and Other Species 32

1. COSEWIC* Species Assessment Information

Date of Assessment: May 2000

Common Name: American Ginseng

Scientific Name: *Panax quinquefolius*

COSEWIC Status: Endangered

Reason for Designation: In spite of restrictions on international trade, high rates of collection continue and there have been significant losses of populations over the last decade.

Canadian Occurrence: Ontario and Quebec

COSEWIC Status History: Designated Threatened in April 1988. Status re-examined and designated Endangered in April 1999. Status re-examined and confirmed in May 2000.

* COSEWIC: Committee on the Status of Endangered Wildlife in Canada. An updated status report has been drafted but has yet to be published (COSEWIC 2011- unpublished).

2. Species Status Information

Less than 1% of the global population of American Ginseng is found in Canada. In 2003, the species was listed as Endangered in Schedule 1 of the federal *Species at Risk Act* (SARA) (S.C. 2002, ch. 29). In Ontario, American Ginseng has been listed as Endangered under the provincial *Endangered Species Act, 2007* (S.O. 2007, ch. 6) (ESA) since 2008. In Quebec, the species has been listed as Threatened[6] under the *Act Respecting Threatened or Vulnerable Species* (R.S.Q., c. E-12.01) (ARTVS) since 2001. Both acts prohibit the harvesting, possession and export of wild American Ginseng.

NatureServe (2017) attributed a global status of G3G4 (vulnerable/apparently secure – last reviewed in 2005) to the American Ginseng and a national status of N2N3 (imperiled/vulnerable – last reviewed in 2011) in Canada and N3N4 (vulnerable/ apparently secure) in the United States. The species has a status of S2 (imperilled) in Quebec and Ontario[7].

[6] The status of Endangered (Ontario) and Threatened (Quebec) are similar and refer to a species facing imminent extinction or extirpation.

[7] Consult http://explorer.natureserve.org/servlet/NatureServe?searchName=Panax+quinquefolius for subnational (State) statutes in the United States.

American Ginseng has also been included in Appendix II[8] of the *Convention on International Trade in Endangered Species* (CITES) since 1973. In Canada, the *Wild Animal and Plant Protection and Regulation of International and Interprovincial Trade Act* (S.C. 1992, c. 52) and the *Wild Animal and Plant Trade Regulations* implement CITES by regulating American Ginseng import and export.

3. Species Information

3.1 Species Description

The content of this section has been simplified in order to limit the release of sensitive information.

White (1988) describes the American Ginseng as a shade-tolerant, forest perennial herb. Individuals have an elongated taproot[9] bearing a thin rhizome and an aerial stem ending in a whorl of palmately-compound leaves (one to four—rarely up to seven). They can live for more than 50 years (Charron, 1989) and reach a height of 20 to 70 cm[10]. The inflorescence[11] is located at the tip of the stem, centred between the compound leaves, and may have multiple flowers.

3.2 Species Population and Distribution

American Ginseng is restricted to North America where it occurs over a large portion of the eastern United States, from New England and Minnesota south to Louisiana and Georgia (Argus and White 1984; Figure 1). In Canada, it occurs in the provinces of Ontario and Quebec. It is considered to be rare or uncommon in most of its range (White 1988; Nault 1998; McGraw et al. *2003*).

The abundance of the American Ginseng in Canadian populations would represent less than 1% relatively to the "many millions if not billions" of individuals in North America (NatureServe 2014). In Ontario, the Natural Heritage Information Centre (NHIC, 2014) reports 287 occurrences[12], including 89 historical (the most recent observation dates

[8] Appendix II includes species that, although currently not threatened with extinction (globally), may become so without trade controls. It also includes species that resemble other listed species and need to be regulated in order to effectively control the trade in those other listed species.

[9] Taproot: an enlarged, somewhat straight to tapering plant root that grows vertically downward. It forms a center from which other roots sprout laterally.

[10] The vigour of individuals can be somewhat stunted in parts of Ontario, some reaching only 10 cm in height (C. Brdar, unpublished data).

[11] Inflorescence: the flowering part of a plant or arrangement of flowers on a stalk.

[12] An area (point, line or map polygon) in which American Ginseng is, or was, present (NatureServe 2002). The occurrence generally corresponds to the habitat occupied by a local population of the species.

back 20 years or more) and 38 considered extirpated[13]. No abundance estimate is available for this province. In Quebec, the Centre de données sur le patrimoine naturel du Québec (CDPNQ 2014) reports over 35,000 American Ginseng plants distributed in 168 occurrences, including 14 historical and 11 extirpated. Because abundance estimates are not available for most extant occurrences in Ontario, population trends are not currently available. However, American Ginseng specialists in Canada report severe declines in most areas.

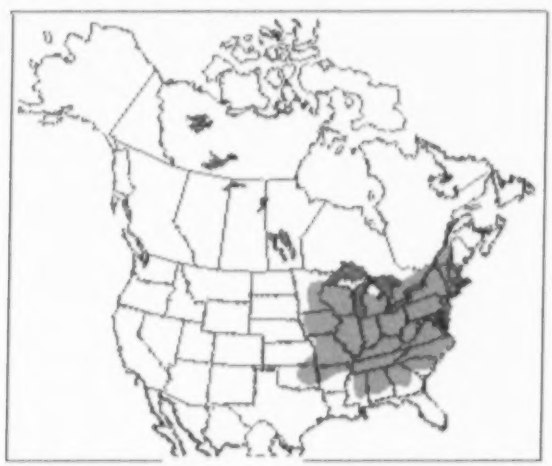

Figure 1. Global distribution of the American Ginseng (Argus and White 1984)

Minimum viable population size has been studied in North America. In Quebec, Nantel et al. (1996)[14] found that viable populations contain at least 172 individuals, show good annual recruitment (seeds survive to produce the next generation) and have a good proportion of mature plants (i.e. at least 100 plants with 3 or 4 leaves). Using this threshold, only 9 populations in Ontario and 54 in Quebec would be considered viable (CDPNQ 2014, NHIC 2014). However, in central Appalachia (United States), viable populations were estimated to have 780 to 820 plants or more (McGraw and Furedi 2005). The impacts of threats such as browsing may explain these vastly different figures and suggest that no single threshold in population viability may exist for American Ginseng.

[13] These figures were provided in April, 2014 by the NHIC, and the 20 year threshold at the time of analysis was 1994. Occurrence numbers are likely to be higher than 287 due to new data that is regularly received, but that has not been fully evaluated by the NHIC at the time of writing the recovery strategy. EC-CWS used information from the NHIC and other available data sources to inform the critical habitat identification and elaborate recovery strategies and approaches.

[14] Given the typically wide confidence intervals of extinction probabilities used in mathematical models, minimum viable population could be anywhere between 50 and 300 plants (P. Nantel, personal communication).

3.3 Needs of the American Ginseng

The content of this section has been simplified in order to limit the release of sensitive information.

The American Ginseng is a shade-tolerant species that typically requires large and relatively undisturbed mature forests for optimal growth conditions (Charron and Gagnon 1991, Nault et al. 1998). As such, it is considered sensitive to edge effects[15] which have been shown to influence the structure and composition of mature eastern North American forests up to approximately 90 m[16] (Harper et al. 2005; Dupont-Hébert 2017). In particular, changes to light levels (and associated soil temperatures) near edges can affect American Ginseng plants as the species is physiologically adapted to low light conditions (10 to 30%; Proctor 1980, Westerveld 2010). Above these levels, plants show signs of leaf chlorosis (yellowing of leaf tissue due to a lack of chlorophyll), early senescence[17], and depressed growth (Gagnon 1999; Jochum et al. 2007).

The canopy of forests occupied by the American Ginseng is usually composed of Sugar Maple (*Acer saccharum*), White Ash (*Fraxinus americana*), Bitternut Hickory (*Carya cordiformis*), Basswood (*Tilia americana*), Red Oak (*Quercus rubra*) and Butternut (*Juglans cinerea*), although some occurrences are found in forests or even swamps with a substantial component of White Cedar (*Thuja occidentalis*) and Hemlock (*Tsuga canadensis*) (Parks Canada Agency, personal communication). Typically, shrubs are sparse, but understory plants are diverse (White 1988; Burkhart 2013).

American Ginseng grows on thick (50-100 cm), well drained soils of glaciary origin that have a relatively neutral pH (6.5-7.5) (White 1988; Couillard et al. 2012).

There are two known pollinators for the American Ginseng, halictid bees and syrphid flies, both of which are generalists (Duke 1980). Once the seeds are produced, their dispersal mainly depends on gravity (Lewis and Zenger 1982; van der Voort 2005), but birds, and in particular thrushes, appear to play an important role in dispersing seeds over a longer distance (Hruska et al. 2014).

Limiting Factors

Limiting factors influence a species' survival and reproduction, and play a major role in the capacity to attain certain population levels (rebound following population declines). For the American Ginseng, they include:

- Long period before plants reach maturity and can produce seeds (7-10 years; White 1988).

[15] Edge effects refer to the changes in population or community structures that occur at the boundary of two habitats (Levine 2009).
[16] This figure was obtained for hard edges (contrasting adjacent habitats).
[17] Senescence: the growth phase in a plant or plant part (as a leaf) from full maturity to death.

- In northern populations, seed production is usually lower (Charron and Gagnon 1991) and germination requires that they remain dormant for a period of at least 18 months (Lewis and Zenger 1982).
- Seedling mortality, namely through drought and predation, is high and can reach 70-90% (Charron and Gagnon 1991, Nault 1998). Seed mortality also reduces the natural recruitment potential of American Ginseng.
- In small populations, rates of self-fertilization may be higher, which produces offspring with lower fitness than in populations with high rates of cross-fertilization (Mooney and McGraw 2007b).
- Allee effect (i.e., problems associated with being in small isolated populations; Hackney and McGraw 2001).
- Most bird species of the Thrush family that play a role in longer distance seed dispersal have been in decline since the late 1960's, with the Wood Thrush (*Hylocichla mustelina*) recently assessed as Threatened by COSEWIC (2012).

4. Threats

4.1 Threat Assessment

Table 1. Threat Assessment Table

Threat	Level of Concern[a]	Extent	Occurrence	Frequency	Severity[b]	Causal Certainty[c]
Utilization of biological resources						
Illegal root harvest	High	Widespread	Current	Recurrent	High	High
Commercial cultivation of American Ginseng	Medium	Localized	Current	Recurrent	Unknown	Unknown
Changes in ecological dynamics or natural processes						
Browsing, predation and diseases (mortality)	High	Widespread	Current	Seasonal	High	Moderate/High
Introduced and invasive species	High	Unknown	Current	Recurrent	Moderate/High	Moderate/High
Habitat loss and degradation						
Deforestation (industrial, urban and agricultural expansion)	High	Widespread	Current	Recurrent	Moderate/High	High
Forest harvesting	Medium/High	Widespread	Current	Recurrent	Moderate/High	Moderate/ High
Climate and natural disasters						
Climate change	Low	Localized	Anticipated	Unknown	Medium	Medium

[a] *Level of Concern: signifies that managing the threat is of (high, medium or low) concern for the recovery of the species, consistent with the population and distribution objectives. This criterion considers the assessment of all the information in the table.*

[b] *Severity: reflects the population-level effect (high: very large population-level effect, moderate, low, unknown).*

[c] *Causal certainty: reflects the degree of evidence that is known for the threat (high: available evidence strongly links the threat to stresses on population viability; medium: there is a correlation between the threat and population viability e.g. expert opinion; low: the threat is assumed or plausible).*

4.2 Description of Threats

The threats described below are presented in order of decreasing level of concern.

Illegal Root Harvest

The medicinal value of Ginseng roots, including American Ginseng, has been recognised in Asia for more than 2000 years (Small et al. 1994). Despite the bans on harvest, possession and export of wild American Ginseng from Quebec (via ARTVS; 2001), Ontario (via ESA; 2008) and from all federal lands where it occurs (via SARA; 2003), COSEWIC (2011 – unpublished report) suggest that more than 50% of surveyed populations in Ontario and 15% of populations in Quebec, including many located in protected areas (see Nault et al. 1998, 2002), show signs of illegal harvest.

Although all illegal harvesting is detrimental to the species through reduced abundance, reproductive potential, genetic diversity and viability (Nault and Tanguay 2011), some practices are more destructive than others. Size of harvested plants and the timing of the harvest season (allowing individuals to produce their seeds) are the two main aspects that determine the impact and lasting effects (McGraw and Ferudi 2005; van der Voort and McGraw 2006; McGraw et al. 2010). There is evidence that American Ginseng plants are smaller than they used to be (McGraw 2001). This may be the result of artificial selection imposed by harvest targeting the biggest plants, leading to reduced fitness of remaining plants as well as reduced seed production within wild populations (Charron and Gagnon 1991; McGraw 2001; Cruse-Sanders and Hamrick 2004; Mooney and McGraw 2007a, 2009). Because the American Ginseng is slow to reach maturity, a 5% annual root harvest is sufficient to bring a viable population to the brink of extirpation (Nantel et al. 1996; McGraw et al. 2013).

Deforestation (Industrial, Urban and Agricultural Expansion)

American Ginseng occurs in the southern parts of Ontario and Quebec where industrial (e.g., resource extraction, energy transportation), urban and agricultural activities have resulted in high levels of habitat loss and continue to put pressure on the mature forests that remain in the landscape. Although agricultural expansion appears to have stabilized over much of the American Ginseng range, and even receded in areas on lower quality soils (e.g., Jobin et al. 2014), urban development has accelerated to the point where it is now considered the leading cause of deforestation in North America (Radeloff et al. 2005; Masek et al. 2011), and a major contributing factor in Canada (Elliott 1998; Jobin et al. 2014).

Exploitation of energy sources (e.g., oil, gas) and minerals (including aggregates) and their transportation (e.g., pipelines, transmission lines, roads) continue to generate habitat loss, degradation and fragmentation throughout the American Ginseng range (Drummond and Loveland 2010; Masek et al. 2011).

Aside from habitat loss, recreational facilities and infrastructures (e.g., trails for hiking and all-terrain vehicles, ski slopes, golf courses) lead to habitat degradation (e.g., soil erosion and compaction, fragmentation, vectors for invasive species, edge effects such as increased density of adjacent vegetation that attracts browsing White-tailed Deer). They have also been found to substantially increase the likelihood of illegal harvest—harvesters have been found to utilize trail networks for species scouting and harvest activities and related harvest impacts have been found to be heavier along trails in provincial nature reserves compared to less-accessible off-trail populations (Young et al. 2011).

Browsing, predation and diseases (mortality)

In Canada and the United States, browsing by White-tailed Deer (*Odocoileus virginianus*) has been documented to cause major impacts on American Ginseng population survival, namely through reduced plant vigour (browsed leaves and flowers are not replaced during the growing season) and significantly reduced seed production (Brdar 2003; Furedi and McGraw 2004; McGraw and Furedi 2005; McGraw et al. 2013; Nault 2013). Prohibitions on hunting in many protected areas have led to deer populations that are unsustainable relative to plant conservation efforts (Nugent et al. 2011). Forest harvesting activities also result in higher deer densities through an increase in understory vegetation used for browsing (Côté et al. 2004). Although the American Ginseng has the capacity to recover from browsing, repeated browsing can lead to substantial changes to the forest understory vegetation which may prove to be difficult or impossible to reverse (Stromayer and Warren 1997).

American Ginseng fruits and seeds are also eaten by small rodents, as empty shells are often found at the base of plants (Nault and Tanguay 2011; McGraw et al. 2013). The overall impact of these predators on the species remains to be clarified but has been shown to be important in many populations in Quebec where the entire annual seed production was removed (A. Nault, personal communication).

Root and foliage diseases caused by fungal pathogens naturally found in the plants' environment are also common (Westerveld 2010).

Introduced and Invasive Species

Invasive species represent one of the five main causes of declines in biodiversity (Millennium Ecosystem Assessment 2005). Invasive slugs (e.g., *Arion rufus, A. fasciatus, A. fuscus*) are increasingly being found at American Ginseng occurrences across North America and they pose the greatest threat to individual plants by feeding on them as they emerge early in spring (Nadeau 2002; Westerveld 2010; McGraw et al. 2013; Nault 2013, 2014; Marineau et al. 2014). Plants that are affected at this early stage are unable to produce leaves or seeds during the growing season and can't accumulate energy within their roots, therefore declining in fitness and decreasing survivorship. Invasive earthworms are also a growing concern due to their capacity to

change the forest floor (Addison 2009), and facilitate invasion by exotic plants (Nuzzo et al. 2009).

Invasive plant species (e.g., Multiflora Rose *Rosa multiflora*, Japanese Barberry *Berberis thunbergii,* Garlic Mustard *Alliaria petiolata,* European Buckthorn *Rhamnus cathartica*; Dog-strangling Vine *Cynanchum rossicum*) are also problematic because they are fierce competitors for resources but also because they can produce chemicals that harm other plants directly (Wixted and McGraw 2009, 2010; Klionsky et al. 2011). They invade after logging or other disturbances (construction, quarry, recreational use, etc.) within or adjacent to occupied forests and quickly become the dominant species, changing the habitat suitability for American Ginseng.

The progression of the Emerald Ash Borer (*Agrilus planipennis*), an invasive insect that attacks ashes, and of the Butternut canker (*Sirococcus clavigignenti-juglandacearum*), an introduced fungus that attacks the Butternut, could represent a significant factor in forests where these species represent an important component. As trees die and the canopy becomes more open, growing conditions may become unsuitable for the American Ginseng because of greater light penetration and increased competition from shrubs and herbaceous vegetation.

Forest Harvesting

American Ginseng is considered to be intolerant to larger openings in the canopy (McConnell and Bjorgan 2004; Couillard et al. 2012; Dupont-Hébert 2017). As such, forest harvesting activities where higher volumes of timber are extracted (e.g., clear-cutting, strip-cutting) directly impact the ecological parameters of a site through increased light penetration at the ground level (opening of the canopy), reduced soil moisture, higher daily temperature fluctuations of the forest floor and increased competition from tree saplings, seedlings as well as shrubs and herbs (White 1988; Nault et al. 1998). Machinery can also create soil erosion and compaction, as well as uproot or crush individuals. In more remote areas, the construction of access roads could facilitate access to poachers.

Harvesting activities where low volumes of timber are extracted to promote the growth of shade-tolerant species may be compatible with the maintenance of American Ginseng (Chamberlain et al. 2013; McGraw et al. 2013; Dupont-Hébert 2017). However, forest stands exploited for maple-syrup production may lead to an oversimplification of the vegetation structure and composition, particularly in the shrub and ground layers.

Commercial Cultivation of American Ginseng

The commercial cultivation of American Ginseng (in woodlots or in agricultural fields) is a growing industry in Canada, with an increase of 4.7% in exportations over the 2007-2011 period[18] (AAFC 2011). Woodland cultivation can affect wild American

[18] www.marquecanadabrand.agr.gc.ca/fact-fiche/pdf/5270-eng.pdf

Ginseng populations through disturbances associated with site preparation (understory clearing) and maintenance (i.e. fertilizers and fungicides), the introduction of pathogens (Reeleder and Fisher 1995) and the introduction of foreign genes by planting seeds from unknown sources (Nault 1998; Grubbs and Case 2004; McGraw et al. 2013). The effects of this threat have received little attention (but see Mooney and McGraw 2007b), particularly in northern populations where individuals may have adaptations for colder weather and other environmental variables (see Souther and McGraw 2011a).

Climate Change

Effects of climate change include the increase in the number of severe weather events such as cold snaps, hurricanes and wind storms (Huber and Gulledge 2011; Kirtman et al. 2013) that have been shown to impact American Ginseng individuals and populations over multiple years (Souther and McGraw 2011b; Souther and McGraw 2014), including long-lasting effects when habitat components are affected. In the eastern Ontario and Quebec portion of the American Ginseng range, a severe ice storm in January of 1998 caused major damage to the forest canopy that has been compared to those observed following heavy selective logging (COSEWIC 2000). Following that event, the third largest population in Quebec (more than 1000 individuals) was reduced to around 300 individuals.

5. Population And Distribution Objectives

The population and distribution objectives for the American Ginseng in Canada are:

- Over the short term (2018-2028): Maintain or increase the abundance of American Ginseng plants and the area of occupied suitable habitat at each extant[19] occurrence[20].
- Over the long term (2018-2038): Ensure the viability of all extant occurrences and, where technically and biologically feasible, restore historical or extirpated occurrences.

These objectives address the species' long-term decline, which was the reason for its designation as Endangered (COSEWIC 2000). The 10-year time frame for the short term objective corresponds to the period between successive COSEWIC assessments of a species' status and is considered reasonable given the challenge working on a high number of extant occurrences.

[19] The term "extant" in the current recovery program refers to the presence of a minimum of one plant within the last 20 years (at the time of development, this threshold was 1994). Historical (H) and extirpated (X) occurrences are not considered.

[20] An occurrence designates an area (point, line or map polygon) in which at least one American Ginseng plant is, or was, present. The term "occurrence" is used here in the broad sense and also comprises known locations that have not yet been included in the conservation data centres even though they come from reliable sources and have been verified by experts.

As for the long-term objective, ensuring that all extant occurrences have viable, self-sustaining populations is necessary given the intense pressure affecting the species and its habitats. At the moment, it is not possible to quantify one single viability threshold with certainty as it likely differs in the various parts of the distribution according to local threats and their intensity, but it would likely fall between 172 and 800 plants.

Finally, many known occurrences of American Ginseng are now considered extirpated or historical. The possibility of restoring these occurrences or reintroducing the species at these locations should be evaluated to support recovery of the species.

These objectives may be reviewed during the development of the report required five years after this strategy is posted to assess the implementation of the strategy and the progress towards meeting its objectives (SARA s. 46).

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Actions Already Completed or Currently Underway

- Many occurrences found in protected areas (provincial, federal, private) or on sites where important American Ginseng populations occur are being managed to ensure their viability (e.g., conservation plans; Nault et al. 2002; Nault 2013, 2014) through partnerships between private landowners, conservation organizations (e.g., Appalachian Corridor, Nature Conservancy Canada) and federal partners.
- Enforcement efforts to protect populations from illegal harvest, including dye-marking roots to increase traceability and reduce marketability within the illegal trade network; and training of enforcement officers (provincial and federal) for search, seizure and investigation techniques to combat illegal harvesting of wild Ginseng.

<u>In Quebec</u>

- A recovery implementation group has been created by the Government of Quebec.
- The Government of Quebec drafted a conservation plan (*Plan de conservation du ginseng à cinq folioles*; Désilets et al. unpublished) that seeks to protect all extant occurrences with a quality rank of Excellent (A) or Good (B); to protect at least one occurrence in each of the physiographic regions (~1000 km^2 units)[21] currently occupied by the species; to protect at least one occurrence in each

[21] Physiographic regions constitute the territorial unit used by the Government of Quebec for protected areas planning and species at risk recovery (Li et al. 1994).

habitat type occupied; and reintroduce the species in physiographic regions where it is historical or extirpated. The Government of Quebec promotes the conservation and recovery of plants at risk in sectors where forestry operations take place by establishing boundaries based on the land-use classification units[22] within which occurrences are found rather than the boundaries of the areas occupied by individuals at each occurrence (Couillard et al. 2012).

- Since 1994, the Montreal Biodome has led a conservation program that aims to: 1) characterize and monitor occurrences; 2) train and provide scientific and technical support for partners that manage priority occurrences, and 3) restore historical or extirpated occurrences.
- Since 2002, permanent plots with deer exclosures have been set up to quantify the impact of deer on one large protected population. Invasive slug exclosures with copper bands are also under experimentation.

In Ontario

- Since 2001, monitoring of a number of occurrences has been undertaken and some historical occurrences have been revisited.
- In 2000-2001, deer exclosures were used in some areas to monitor the impact of deer browsing on vegetation.
- From 2002 to 2010, a group of biologists from the Ontario Ministry of Natural Resources[23] formed the American Ginseng Recovery Implementation Group. Annual efforts included collecting and planting seeds, removing seeds from visible individuals, monitoring existing populations, finding new populations, educating key staff, and creating visual screening of visible populations.
- In 2010, OMNR published its *Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales* (OMNR 2010) which is to be used by forest managers when planning and implementing forestry operations on Crown land. This document outlines the operational prescription for areas with American Ginseng in order to protect the species from negative impacts from the forestry operations and is based on the directives developed by McConnell and Bjorgan (2004).
- As of 2013, the general habitat for the American Ginseng has been described (http://files.ontario.ca/environment-and-energy/species-at-risk/mnr_sar_ghd_amr_gnsg_en.pdf) (OMNR 2013) and is protected under Ontario's *Endangered Species Act*, 2007

[22] This system is used for land-use planning and particularly for forestry operations in Quebec, making it easier to incorporate the protection of species at risk as part of regular planning efforts that take place over much larger landscapes. Furthermore, by incorporating areas of suitable habitat larger than those that may be currently colonized, an increase in abundance is possible and edge effects are reduced.
[23] In July, 2014, the Ontario Ministry of Natural Resources (OMNR) became the Ontario Ministry of Natural Resources and Forestry (MNRF).

6.2 Strategic Direction for Recovery

Table 2. Recovery Planning Table.

Threat or Limitation	Broad Strategy to Recovery	Priority[a]	General Description of Research and Management Approaches
All	Stewardship and management of the species and its suitable habitat	High	• Provide legal protection or binding stewardship status to areas of significance for the species • Implement beneficial management practices (BMP) at the local and landscape levels in order to mitigate threats, with an emphasis on illegal harvest as well as plant and seed mortality • Restore habitats and reintroduce the species within historical and extirpated occurrences
Knowledge gaps	Monitoring and Research	High	• Conduct demographic and genetic studies to clarify how American Ginseng populations respond to various threats • Study aspects related to the propagation of individuals (e.g., pollinators; *ex situ* cultivation for transplantation and reintroduction purposes; short and long distance dispersal pathways)
		Medium	• Implement standardized protocols to monitor the species' populations, habitat characteristics and threats • Develop, validate or improve models (e.g. detectability, habitat suitability, population viability) • Survey and monitor current extant occurrences as well as surveying new occurrences and encourage reporting to CDCs to update occurrences current data.
All	Communication and Outreach	High	• Establish partnerships with governmental departments and agencies, conservation organizations, Indigenous communities, private landowners and the commercial cultivation industry in order to implement a training/outreach/restoration/reintroduction program • Consider the creation of a North American working group • Improve the communication and data management for species with sensitive data (e.g., educate the media, secure data storage and exchange)

All threats	Law and Policy	High	• Promote and verify the compliance with existing environmental laws, regulations and policies to prevent breaches and offenses for all types of activities on all types of land tenures • Develop new policies and programs where gaps exist

[a] *"Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.*

7. Critical Habitat

7.1 Identification of the Species' Critical Habitat

Section 41(1)(c) of SARA requires that recovery strategies include an identification of the species' critical habitat, to the extent possible, as well as examples of activities that are likely to result in its destruction. Under section 2(1) of SARA, critical habitat is "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species".

This recovery strategy partially identifies critical habitat, based on the best available information for the American Ginseng as of October 2014. The Schedule of Studies (section 7.2) outlines the activities required to complete the identification of the critical habitat necessary to meet the population and distribution objectives. As new information becomes available, boundaries may be modified and additional critical habitat may be identified.

The identification of critical habitat for the American Ginseng is based on two criteria: habitat occupancy and habitat suitability.

7.1.1 Habitat Occupancy

Habitat occupancy by the species is established from existing occurrence records[24] (quality ranks A, B, C, D or E[25]) based on the data available (at the time of analysis) from conservation data centres (CDPNQ, NHIC). The records associated with imprecise[26], historical (H)[27] and extirpated (X) occurrences are excluded. Only data

---

[24] A record corresponds to a location of a biodiversity element georeferenced during a field survey. It does not necessarily correspond to a plant; it may be the centroid of a subpopulation that has several plants.

[25] The CDPNQ and NHIC rank the quality of occurrences using the NatureServe (2002) methodology that considers the number of individuals (abundance) and/or the integrity of the habitat they occupy: A: Excellent (>500 individuals); B: Good (>500 individuals and presence of threats or 176-500 individuals); C: Medium (176-500 individuals and presence of threats or 51-175 individuals); D: Low (51-175 individuals and the presence of threats or < 51 individuals); E: Recent (not ranked); H: Historical; X: Extirpated.

[26] Occurrences and observations points with a degree of imprecision greater than 150 m.

[27] Twenty years is the threshold set by the conservation data centres on the basis of which an occurrence is considered to be historical. The 20 year threshold was 1994 at the initiation of this recovery strategy, and it will be considered the threshold for critical habitat at this time until or if the critical habitat criteria are revised in the future.

from 1994 to 2013 (inclusive) corresponding to wild plants[28] are considered. Records from other sources that may be awaiting integration into an existing occurrence or the assignment of an occurrence number are included.

7.1.2 Habitat Suitability

Habitat suitability refers to areas possessing a specific set of biophysical attributes that can support individuals of the species carrying out essential aspects of their life cycle. The biophysical attributes for American Ginseng suitable habitat in Canada are provided in Table 3 (refer to section 3.3 Needs of the species for references).

Suitable habitat for American Ginseng is described using a critical function zone of up to 150 m around each plant. The first 100 m serves to maintain the biophysical attributes necessary to support the complete life cycle, facilitate short distance seed dispersal and reduce edge effects (see "suitable growth habitat" in Table 3). An additional 50 m can extend into other types of forests or treed swamps, that although they may not meet all the required biophysical attributes for American Ginseng plants to grow, will contribute tomaintaining suitable habitat conditions (e.g., moisture, reduced light penetration) in adjacent suitable growth habitat, as well as facilitate long distance seed dispersal and limit the potential invasion by exotic species (Harper et al. 2005). The distance of 150 m is confirmed by a recent study conducted for the Government of Quebec (Dupont-Hébert 2017), which demonstrated that the majority of the observation points are found more than 150 m from disturbed open habitats, such as fields and roads. Suitable habitat thus excludes this type of habitat. This definition of suitable habitat is consistent with the *General Habitat Description for American Ginseng* (OMNR 2013) protected by the Government of Ontario under the provincial *Endangered Species Act, 2007*.

[28] Plants grown from non-native American Ginseng plants for commercial harvesting purposes are excluded. Plants grown from Wild American Ginseng seeds for restoration or reintroduction are considered.

Table 3. Description of the Biophysical Attributes of Suitable Habitat for the American Ginseng.

Components of suitable habitat	Biophysical Attributes
Suitable growth habitats	• Structure is typical of mature forests (e.g., more than 90 years old) or older secondary forests with few recent disturbances (e.g., large trees, closed-canopy) • Composition of trees is deciduous or mixed with species such as Sugar Maple, White Ash, Bitternut Hickory, Basswood, Red Oak, and Butternut; although some populations are found in White Cedar or Hemlock forests/swamps • Shrub cover is relatively sparse (<25%) and understory companion plant species are generally diverse • Soils are usually of glaciary origin, thick (50 to 100 cm), well drained (drainage classes of 20-well or 30-moderate) and have a relatively neutral pH; although some populations are found on very shallow, rocky soils, sometimes growing directly in small crevices in dolomitic limestone • Light penetration at ground level is low (under 30%; typical of closed-canopy forests) ➢ Applies within a maximum radius of 100 m surrounding each plant
Habitats that maintain the attributes of suitable growth habitats	• Other forest habitats and treed swamps ➢ Applies within a maximum radius of 50 m over and above that associated with habitats suitable for growth around each plant

7.1.3 Application of the Critical Habitat Criteria

Critical habitat for the American Ginseng is partially identified in this recovery strategy. It corresponds to the areas of suitable habitat within a 150 m critical function zone around existing occurrence records of American Ginseng.

The identification of critical habitat is considered partial as most of the known occurrences or sites are not currently considered viable and the exact locations of some of the occurrences are not known. Furthermore, some occurrences have limited attribute information on individual plant locations, abundance, area of occupancy or viability of the occurrence.

Finally, some of the historical or extirpated occurrences that may be necessary to reach the long term population and distribution objectives are not included in the critical habitat. This species is highly under-surveyed and under-reported to provincial CDCs, and as a result any of the critical habitat identification is limited to available information. The schedule of studies in the following section will make up for these shortcomings.

Following the application of these criteria, 455 critical habitat units containing 8268 ha within the critical habitat zone are identified in Canada, including 334 in Ontario (3,635 ha) and 121 in Quebec (4633 ha). Due to the sensitivities of the species (e.g. illegal harvest), the Minister of the Environment and Climate Change, on the advice of COSEWIC, has restricted the release of information that relates to the location of American Ginseng or its habitat (SARA s. 124). Accordingly, Appendix A (Tables A-1 and A-2) presents the general locations of critical habitat using a 100 x 100 km standardized national UTM grid system. More detailed information on the location of critical habitat to support protection of the species and its habitat may be requested, on a need-to-know basis, by contacting Environment and Climate Change Canada's Recovery Planning section at: ec.planificationduretablissement-recoveryplanning.ec@canada.ca.

Any areas within the critical habitat units that do not possess the biophysical attributes of critical habitat (e.g., houses, roads and trails, paved surfaces, military ranges, agricultural fields, golf courses) are not identified as critical habitat.

7.2 Schedule of Studies to Identify Critical Habitat

Table 4. Schedule of Studies to Identify Critical Habitat.

Description of Activity	Rationale	Timeline
Confirm location, obtain population information and assess habitat suitability of historical occurrences and occurrences considered extant that are under-surveyed, under-reported or have insufficient spatial accuracy. In addition, use this information to review, update and/or refine existing observations and American Ginseng occurrences as per NatureServe protocols.	Necessary to reach the short-term and long-term population and distribution objectives	2018-2020
Proceed with an assessment of historical occurrences to determine if individuals or suitable habitat are still present. If assessment is positive, proceed with identification as critical habitat.	Necessary to reach the long-term population and distribution objective	2018-2028
Proceed with an assessment of extirpated occurrences to determine if habitat restoration and American Ginseng reintroduction is technically and biologically feasible. If assessment is positive, proceed with identification as critical habitat.	Necessary to reach the long-term population and distribution objective	2018-2038

7.3 Activities Likely to Result in the Destruction of Critical Habitat

Understanding what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. Destruction is determined on a case by case basis. Destruction would result if part of the critical habitat were degraded, either permanently or temporarily, such that it would not serve its function when needed by the species. Destruction may result from a single or multiple activities at one point in time or from the cumulative effects of one or more activities over time (Government of Canada 2009). Activities described in Table 5 include those likely to cause destruction of critical habitat for the species; however, destructive activities are not limited to those listed.

Table 5. Examples of Activities Likely to Result in the Destruction of Critical Habitat for the American Ginseng.

Description of Activity	Description of Effect	Details of Effect
Construction and maintenance (e.g., mowing, use of pesticides) of linear infrastructures (e.g., roads, highways, trails, energy corridors, pipelines).[a] All-terrain vehicle use and high foot traffic.[a]	Loss and/or degradation of suitable habitat including : - vegetation removal (e.g., forest cover) resulting in over 30% light penetration - the soil is covered permanently - drainage conditions are modified (e.g. results in poorly-drained soils) - any soil disturbance that would change the vegetation and soil parameters identified in Table 3 (e.g., all-terrain vehicles introducing and/or providing disturbed sites for invasive and introduced species that modify the structure and composition of vegetation and compete for resources) - edge effects into the adjacent forest (e.g., increased light penetration, moisture conditions, ground temperatures; denser shrub and ground layers attract deer who modify vegetation structure and composition through browsing)	Constitutes destruction if the biophysical characteristics in the critical function zone corresponding to suitable habitat for American Ginseng no longer allow for maintenance of the species at the site (zone may extend up to 100 m around plants) Constitutes destruction if the activities carried out in the critical function zone corresponding to habitat that maintains the attributes of suitable growth habitat for American ginseng no longer allow for maintenance of the species at the site (zone may extend up to 50 m from the zone mentioned above)
Industrial expansion (e.g., mineral extraction, aggregates, industrial areas)		
Urban expansion (e.g., houses, recreational areas and structures)		
Agricultural expansion		
Forest harvesting where higher volumes of timber are harvested (e.g., clear-cutting, strip-cutting)	Loss and degradation of suitable habitat including : - Cutting trees to a level that increases light penetration (exceeding 30%), reduces moisture and favours denser shrub and ground layers that attract deer who modify vegetation structure and composition through browsing - Machines damage the forest floor by destroying vegetation and contributing to soil erosion, compaction and leading to changes to drainage - Access roads are built, destroying, fragmenting, creating edge effects and facilitating access to illegal harvesters, invasive species and White-tailed Deer - Change to forest structure and composition due to selection of species to be harvested and by recruitment of opportunistic or invasive species	

Commercial cultivation of ginseng in woodlots (e.g. site preparation)	Can result in direct or indirect degradation of the vegetation structure and composition[b]	Could constitute destruction if the biophysical characteristics in the area corresponding to suitable habitat for American Ginseng no longer allow for the maintenance of the species at the site (zone may extend up to 100 m around plants)

[a] Some of these activities may not constitute habitat destruction if they are conducted outside of the growing season (early May to end of September) and do not result in the modification of conditions for future growing seasons.

[b] This activity can lead to the introduction of foreign genetic material as well as diseases that may affect plant vigour and seed production (these aspects are not related to critical habitat).

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

- Over the short term (2018-2028), the abundance of American Ginseng plants and the area of occupied suitable habitat at each extant occurrence has been maintained or increased;
- Over the long term (2018-2038), the viability of all extant occurrences has been reached and, where biologically and technically feasible, historical and extirpated occurrences have been restored.

9. Statement On Action Plans

One or more action plans for the American Ginseng will be posted on the Species at Risk Public Registry by the end of 2023.

10. References

AAFC. 2011. Canada's North American Ginseng. Agriculture and Agri-Food Canada. 4 p. http://www.marquecanadabrand.agr.gc.ca/fact-fiche/5270-eng.htm

Addison, J.A. 2009. Distribution and impacts of invasive earthworms in Canadian forest ecosystems. Biological Invasions 11:59–79.

Argus, G.W. and J. White. 1984. *Panax quinquefolium* L. In G.W. Argus and C.J. Keddy, ed. Atlas of the rare vascular plants of Ontario, part 3. Natural Science Museum, Canadian National Museum, Ottawa.

Brdar, C. 2003. American Ginseng monitoring and recovery – Summary of field work and findings, South Eastern zone, 2002-2003. Ontario Parks. Confidential report, 15 p.

Burkhart, E.P. 2013. American Ginseng (*Panax quinquefolius* L.) floristic associations in Pennsylvania: guidance for identifying calcium-rich forest farming sites. Agroforestry Systems 87(5): 1157-1172.

CDPNQ. 2014. Ginseng à cinq folioles. Centre de données sur le patrimoine naturel du Québec. Québec.

Chamberlain, J. L., Prisley, S., and M. McGuffin. 2013. Understanding the relationships between American Ginseng harvest and hardwood forests inventory and timber harvest to improve co-management of the forests of the eastern United States. Journal of Sustainable Forestry 32: 605-624.

Charron, D. 1989. La dynamique des populations de ginseng (*Panax quinquefolium* L.) dans le sud du Québec. Master's thesis. Université du Québec à Montréal. 110 p.

Charron, D. and D. Gagnon. 1991. The demography of northern populations of *Panax quinquefolium* (American Ginseng). Journal of Ecology 79: 431-445.

COSEWIC. 2000. COSEWIC assessment and update status report on the American Ginseng *Panax quinquefolius* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 17 p.

COSEWIC. 2012. COSEWIC assessment and status report on the Wood Thrush *Hylocichla mustelina* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. ix + 46 pp.

COSEWIC. Unpublished. Draft (December 2011) COSEWIC status report on the American Ginseng *Panax quinquefolius* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 42 p.

Côté, S.D., T.P. Rooney, J.-P. Tremblay, C. Dussault, and D.M. Waller. 2004. Ecological Impacts of Deer Overabundance. Annual Review of Ecology. Evolution and Systematics 35: 113–147.

Couillard L., N. Dignard, P. Petitclerc, D. Bastien, A. Sabourin, et J. Labrecque. 2012. Guide de reconnaissance des habitats forestiers des plantes menacées ou vulnérables. Outaouais, Laurentides et Lanaudière. Ministère des Ressources naturelles et de la Faune et ministère du Développement durable, de l'Environnement et des Parcs. 434 p.

Cruse-Sanders, J.M. and J.L. Hamrick. 2004. Spatial and genetic structure within populations of wild American Ginseng (*Panax quinquefolius* L. Araliaceae). Journal of Heredity 95: 309–321.

Désilets, P., G., Jolicoeur, et L. Couillard. Unpublished. Plan de conservation du ginseng à cinq folioles (*Panax quinquefolius*), Espèce menacée au Québec. Gouvernement du Québec, Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs, Direction du patrimoine écologique et des parcs, Québec. 26 p.

Drummond, M.A. and T.R. Loveland. 2010. Land-use Pressure and a Transition to Forest-cover Loss in the Eastern United States. BioScience 60: 286–298.

Duke, J.A. 1980. Pollinators of *Panax*? Castanea 45:141.

Dupont-Hébert, M. 2017. Ginseng à cinq folioles (Panax quinequefolius), Analyse spatiale des perturbations environnantes. Bureau d'écologie appliquée pour le ministère du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques, Québec. 23 p.

Elliott, K. A. 1998. The forests of southern Ontario. The Forestry Chronicle 74 (6): 850-854.

Furedi, M.A. and J.B. McGraw. 2004. White-tailed deers: Dispersers or predators of American Ginseng seeds? The American Midland Naturalist 152(2): 268-276.

Gagnon, D. 1999. An analysis of the sustainability of American ginseng harvesting from the wild: the problem and possible solutions. US Fish and Wildlife Service, Office of Scientific Authority. 24 p.

Government of Canada. 2009. *Species at Risk Act* policies, Overarching framework [Draft]. *Species at Risk Act* policy and guideline Series. Environment Canada. Ottawa. 38 pp.

Grubbs, H.J. and M. A. Case. 2004. Allozyme variation in American Ginseng (*Panax quinquefolius* L.): Variation, breeding system, and implications for current conservation practice. Conservation Genetics 5: 13-23.

Hackney, E. and J.B. McGraw. 2001. Experimental demonstration of an Allee effect in American ginseng. Conservation Biology 15(1):129-136.

Harper, K.A., S.E. MacDonald, P.J. Burton, J. Chen, K.D. Brosofske, S.C. Saunders, E.S. Euskirchen, D. Roberts, M.S. Jaiteh, and P. Esseen. 2005. Edge influence on forest structure and composition in fragmented landscapes. Conservation Biology 19(3): 768-782.

Hruska, A., S. Souther, and J.B. McGraw. 2014. Songbird dispersal of American ginseng (*Panax quinquefolius* L.). Ecoscience 21(1): 46-55.

Huber, D. G. and J. Gulledge. 2011. Extreme weather and climate change: understanding the link, managing the risk. Center for Climate and Energy Solutions, Arlington, VA.

Jobin, B., C. Latendresse, A. Baril, C. Maisonneuve, and D. Côté. 2014. A half-century analysis of landscape dynamics in southern Québec, Canada. Environmental Monitoring and Assessment 186: 2215–2229.

Jochum, G. M., K. W. Mudge, and R. B. Thomas. 2007. Elevated temperatures increase leaf senescence and root secondary metabolite concentrations in the understory herb *Panax quinquefolius* (Araliaceae). American Journal of Botany 94: 819-826.

Kirtman, B., S.B. Power, J.A. Adedoyin, G.J. Boer, R. Bojariu, I. Camilloni, F.J. Doblas-Reyes, A.M. Fiore, M. Kimoto, G.A. Meehl, M. Prather, A. Sarr, C. Schär, R. Sutton, G.J. van Oldenborgh, G. Vecchi and H.J. Wang. 2013: Near-term Climate Change: Projections and Predictability. *In* Stocker, T.F., D. Qin, G.-K. Plattner, Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., and P.M. Midgley (eds.). Climate Change 2013: The physical science basis. Contribution of working group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Klionsky, S.M., K.L. Amantangelo and D.M. Waller. 2011. Above- and belowground impacts of European Buckthorn (*Rhamnus cathartica*) on four native forbs. Restoration Ecology Vol. 19, No. 6, pp. 728–737. doi: 10.1111/j.1526-100X.2010.00727.x

Levine. S.A. 2009. The Princeton Guide to Ecology. Princeton University Press. 848 p.

Lewis, W. H. and V. E. Zenger. 1982. Population dynamics of the American Ginseng *Panax quinquefolium* (*Araliaceae*). American Journal of Botany 69(9): 1483-1490.

Lewis, W. H. and V. E. Zenger. 1983. Breeding systems and fecundity in the American ginseng, *Panax quinquefolium* (Araliaceae). American Journal of Botany 70: 466-468.

Li, T., J. Bissonnette, J.P. Ducruc, V. Gérardin and L. Couillard. 1994. Le cadre écologique de référence du Québec : les régions naturelles, Présentation générale. Ministère de l'Environnement et de la Faune du Québec, 20 p.

Marineau, K., Y. Tendland and M.-E. Tousignant. 2014. Revue de littérature sur les méthodes de contrôle des limaces et des agents nuisibles (cerfs, rongeurs) ainsi que sur les facteurs affectant une plante en péril [title abbreviated to limit the communication of sensitive data]. Rapport final présenté à Environnement Canada. 28 p.

Masek, J.G., W.B. Bohen, D. Leckie, M.A. Wulder, R. Vargas, B. de Jong, S. Healey, B. Law, R. Birdsey, R.A. Houghton, D. Mildrexler, S. Goward and W.B. Smith. 2011. Recent rates of forest harvest and conservation in North America. Journal of Geophysical Research 116 G00K03 doi:10.1029/2010JG001471.

McConnell, A. and L. Bjorgan. 2004. Directive for protecting American Ginseng habitat during forest management operations on crown land in Southern region, Ontario. DRAFT, version 5.0. Ontario Ministry of Natural Resources. 31 p.

McGraw, J. B. 2001. Evidence for decline in stature of American Ginseng plants from herbarium specimens. Biological Conservation 98: 25- 32.

McGraw, J.B. and M. A. Furedi. 2005. Deer browsing and population viability of a forest understory plant. Science 307: 920-922.

McGraw, J. B., S. M. Sander, and M. E. Van der Voort. 2003. Distribution and abundance of *Hydrastis canadensis* L. (Ranunculaceae) and *Panax quinquefolius* L. (Araliaceae) in the central Appalachian region. Journal of the Torrey Botanical Club 130(2): 62-69.

McGraw, J. B., S. Souther, and A. E. Lubbers. 2010. Rates of harvest and compliance with regulations in natural populations of American ginseng (*Panax quinquefolius* L.). Natural Areas Journal 30:202-210.

McGraw, J.B., Lubbers, A.E., Van der Voort, M., Mooney, E.H., Furedi, M.A., Souther, S., Turner, J.B., and J. Chandler. 2013. Ecology and conservation of ginseng (*Panax quinquefolius*) in a changing world. Annals of the New York Academy of Sciences 1286: 62-91.

Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Biodiversity synthesis (A report of the Millennium Ecosystem Assessment). Washington, DC, World Resources Institute. 100 p.

Mooney, E. H. and J.B. McGraw. 2007a. Alteration of selection regime resulting from harvest of American ginseng, *Panax quinquefolius*. Conservation Genetics 8:57-67.

Mooney, E.H. and J.B. McGraw. 2007b. Effects of self-pollination and outcrossing with cultivated plants in small natural populations of American ginseng, *Panax quinquefolius* (Araliaceae). American Journal of Botany 94:1677-1687.

Mooney, E. H. and J. B. McGraw. 2009. Relationship between age, size and reproduction in populations of American ginseng, *Panax quinquefolius* (Araliaceae), across a range of harvest pressures. Ecoscience 16(1):84-94.

Nadeau, I. 2002. Guide sur la culture du ginseng en milieu forestier. Ginseng Boréal. 92 p.

Nantel, P., D. Gagnon and A. Nault. 1996. Population viability analysis of American Ginseng and wild leek harvested in stochastic environments. Conservation Biology 10: 608-620.

NatureServe. 2002. Element occurrence data standard. http://downloads.natureserve.org/conservation_tools/element_occurence_data_standard.pdf

NatureServe. 2017. NatureServe Explorer: An online encyclopedia of life. NatureServe, Arlington, Virginia. Online: http://explorer.natureserve.org (Accessed April 10, 2014).

Nault, A. 1998. La situation du ginseng à cinq folioles (*Panax quinquefolius* L.) au Québec. Gouvernement du Québec, ministère de l'Environnement et de la Faune, Direction de la conservation et du patrimoine écologique, Québec. 43 p.

Nault, A. 2013. Rapport de situation pour la conservation du ginseng à cinq folioles [title abbreviated to limit the communication of sensitive data]. Rapport préparé pour Environnement Canada. 39 p.

Nault, A. 2014. Mesures prioritaires de rétablissement pour le ginseng à cinq folioles [title abbreviated to limit the communication of sensitive data]. Rapport préparé pour Environnement Canada. 30 p.

Nault, A., D. Gagnon, D. White, and G. Argus. 1998. Conservation of ginseng in Ontario. Report 1997/1998. Ministry of Natural Resources, Science and Technology - East Science Unit. Unpublished report. 89 p.

Nault, A. et C. Tanguay. 2011. Conservation et restauration du ginseng à cinq folioles au Québec. Guide de référence. Biodôme de Montréal. 68 p.

Nault, A., V. Bachand-Lavallée and D. Gagnon. 2002. Implementation of conservation measures in five parks of Eastern Ontario. Ontario Parks. 35 p.

NHIC. 2014. Natural Heritage Information Centre, Ontario Ministry of Natural Resources and Forestry. Peterborough, Ontario.

Nugent, G., W.J. McShea, J. Parkes, S. Woodley, J. Waithaka, J. Moro, R. Gutierrez, C. Azorit, F. Mendez Guerrero, W. T. Flueck and J. M. Smith-Flueck. 2011. Policies and management of overabundant deer (native or exotic) in protected areas. Animal Production Science 51: 384-389.

Nuzzo, V.A., J.C. Maerz, and B. Blossey. 2009. Earthworm invasion as the driving force behind plant invasion and community change in northeastern North American forests. Conservation Biology 23(4): 966–974.

OMNR. 2010. Forest management guide for conserving biodiversity at the stand and site scales. Ontario Ministry of Natural Resources. Toronto: Queen's Printer for Ontario. 211 pp. Online: http://www.ontario.ca/environment-and-energy/forest-management-guide-conserving-biodiversity-stand-and-site-scales-stand-and-site-guide (Accessed November 6, 2014).

OMNR. 2013. General habitat description for the American Ginseng (*Panax quinquefolius*). Ontario Ministry of Natural Resources. 4 p.

Proctor R. 1980. Some aspects of the Canadian culture of ginseng (*Panax quinquefolius* L.) particularly the growing environment. Pages 39-48 *In* Proceedings of the third national ginseng symposium. Korean Ginseng Institute, Seoul, Korea.

Radeloff, V.C., R.B. Hammer and S.I. Stewart. 2005. Rural and sub-urban sprawl in the U.S. Midwest from 1940 to 2000 and its relation to forest fragmentation. Conservation Biology 19:793-805.

Reeleder, R.D. and P. Fisher. 1995. Diseases of ginseng. Fact sheet 95-003, Ontario Ministry of Agriculture, Food and Rural Affairs. 4 p.

Small, E., P.M. Catling and E. Haber. 1994. Poorly known economic plants of Canada. Ginseng – *Panax quinquefolius* L. CBA/ABC Bulletin 27(4):70-72.

Souther, S. and J. B. McGraw. 2011a. Evidence of local adaptation in the demographic response of American ginseng to interannual temperature variation. Conservation Biology 25(5):922-931.

Souther, S. and J. B. McGraw. 2011b. Vulnerability of wild American ginseng to an extreme early spring temperature fluctuation. Population Ecology 53:119–129.

Souther, S. and J.B. McGraw 2014. Synergistic effects of climate change and harvest on extinction risk of American ginseng. Ecological Applications 24:1463–1477.

Stromayer, K.A.K. and R.J. Warren. 1997. Are overabundant deer herds in the eastern United States creating alternate stable states in forest plant communities? Wildlife Society Bulletin 25(2): 227-234.

Van der Voort, M. E., 2005. An ecological and demographic study of American ginseng (*Panax quinquefolius* L.) in central Appalachia. Ph.D. dissertation, West Virginia University Morgantown, West Virginia.

Van der Voort, M. E. and J. B. McGraw. 2006. Effects of harvester behavior on population growth rate affects sustainability of ginseng trade. Biological Conservation 130: 505-516.

Westerveld, S. 2010. Ginseng production in Ontario. Ontario Ministry of Agriculture and Food and Rural Affairs. Factsheet No. 10-081W AGDEX 268. 8 p.

White, D.J. 1988. Ecological study and status report on American Ginseng *Panax quinquefolium* L. A threatened species in Canada. Committee on the status of endangered wildlife in Canada. Canadian Wildlife Service. 170 p.

Wixted, K. and J. B. McGraw. 2009. A Panax-centric view of invasive species. Biological Invasions 11(4): 883-893.

Wixted, K. and J. B. McGraw. 2010. Competitive and allelopathic effects of garlic mustard (*Alliaria petiolata*) on American ginseng (*Panax quinquefolius*). Plant Ecology 208:347–357.

Young, J.A., F.T. van Manen and C.A. Thatcher. 2011. Geographic Profiling to Assess the Risk of Rare Plant Poaching in Natural Areas. Environmental Management 48 (3): 577-587

Appendix A: Critical Habitat for the American Ginseng in Canada

The content of this section has been simplified in order to limit the release of sensitive information. For example, land tenure within each square is not provided.

Table A-1. Critical Habitat for the American Ginseng in Ontario occurs within these 100 x 100 km Standardized UTM grid Squares where Criteria Described in Section 7 are met.

100 x 100 km Grid Square ID[a]	UTM Grid Square Coordinates[b]	
	Easting	Northing
17TMG	400000	4600000
17TMH	400000	4700000
17TMJ	400000	4800000
17TMK	400000	4900000
17TNH	500000	4700000
17TNJ	500000	4800000
17TNK	500000	4900000
17TPH	600000	4700000
17TPJ	600000	4800000
17TPK	600000	4900000
17TPL	600000	5000000
18TTP[c]	256723	4800000
18TTQ	260346	4900000
18TUR	300000	5000000
18TVQ	400000	4900000
18TVR	400000	5000000
18TWQ	500000	5000000
18TWR	500000	5000000

[a] Based on the standard UTM Military Grid Reference System (see http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789), where the first 2 digits and letter represent the UTM Zone, the following 2 letters indicate the 100 x 100 km standardized UTM grid. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See http://www.bsc-eoc.org/ for more information on breeding bird atlases).

[b] The listed coordinates are a cartographic representation of where critical habitat can be found, presented as the southwest corner of the 100 x 100 km standardized UTM grid square containing all or a portion of the critical habitat unit. The coordinates may not fall within critical habitat and are provided as a general location only.

[c] Due to their significantly smaller area, UTM squares falling at the intersection of UTM zones as well as UTM squares with less than 50% situated within Canada are merged with the closest complete UTM square or merged to form a square/rectangle with an area close to 100 x 100 km. This method is applied even if constituent squares do not all contain critical habitat in order to prevent the release of sensitive information. The listed coordinates correspond to those of the southwest corner of the resulting merged square/rectangle.

Table A-2. Critical Habitat for the American Ginseng in Quebec occurs within these 100 x 100 km Standardized UTM grid Squares where Criteria Described in Section 7 are met.

100 x 100 km Grid Square ID[a]	UTM Grid Square Coordinates[b]	
	Easting	Northing
18TWQ	500000	4900000
18TXQ	600000	4900000
18TYQ	700000	4900000
18TUR	300000	5000000
18TVR	400000	5000000
18TWR	500000	5000000
18TXR	600000	5000000
18TYR	700000	5000000
18TVS	400000	5100000
19TBL[c]	264028	5000000
19TBM	267767	5100000

[a] Based on the standard UTM Military Grid Reference System (see http://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9789), where the first 2 digits and letter represent the UTM Zone, the following 2 letters indicate the 100 x 100 km standardized UTM grid. This unique alphanumeric code is based on the methodology produced from the Breeding Bird Atlases of Canada (See http://www.bsc-eoc.org/ for more information on breeding bird atlases).

[b] The listed coordinates are a cartographic representation of where critical habitat can be found, presented as the southwest corner of the 100 x 100 km standardized UTM grid square containing all or a portion of the critical habitat unit. The coordinates may not fall within critical habitat and are provided as a general location only.

[c] Due to their significantly smaller area, UTM squares falling at the intersection of UTM zones as well as UTM squares with less than 50% situated within Canada are merged with the closest complete UTM square or merged to form a square/rectangle with an area close to 100 x 100 km. This method is applied even if constituent squares do not all contain critical habitat in order to prevent the release of sensitive information. The listed coordinates correspond to those of the southwest corner of the resulting merged square/rectangle.

Appendix B: Effects on the Environment and Other Species

The content of this section has been simplified in order to limit the release of sensitive information.

A strategic environmental assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[29]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[30] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

This federal recovery strategy will clearly benefit the environment by promoting the recovery of American Ginseng. The potential for the strategy to inadvertently lead to adverse effects on other species was considered. The SEA concluded that this strategy will clearly benefit the environment and will not result in any significant adverse effects.

The majority of recovery approaches suggested in this document should have limited or positive effects on non-target species, natural communities or ecological processes. All actions related to further habitat protection would bring direct benefits to the numerous species sharing the American Ginseng's habitat, including other federally-listed species.

[29] www.ceaa.gc.ca/default.asp?lang=En&n=B3186435-1
[30] www.ec.gc.ca/dd-sd/default.asp?lang=En&n=F93CD795-1